

**DIE SET, MACHINE AND METHOD FOR FORMING DIE-PRESSED  
CARTRIDGE CASES**

DESCRIPTION

5     The present invention relates to a die set, a machine and a method for forming a cartridge case.

10     In the technical sector cartridges for smooth-bore guns, such as hunting and clay-pigeon shooting rifles, are known; these cartridges are formed by a plastic or cardboard tube containing the propelling firing charge, the firing wad and shot, and a case which is made of brass or brass/nickel-coated steel and houses the priming charge and the so-called base wad. It is also known that the process for producing the case envisages:

- 15     i.    using dies at intervals with a limited width of the sheet metal which can be used and large amount of machining waste since the workpiece is transferred from a matrix of the die to the next one still joined to the metal sheet by means of connecting pieces or "webs", or:
- 20     ii.   a sequence of successive steps involving shearing, multi-stage drawing and/or die-forming and boring; in addition to these steps there are further steps
- 25     for widening the base of the case and if necessary printing the details of the cartridge on the said base.

30     In order to distinguish the cartridge, it may also be personalized by printing trademarks, designs and the like which, however, is performed by means of tampography or serigraphy on the external surface of the tube, i.e. by means of special machines which are able to print on curved surfaces and which require management of the ink supply and drying of the inks at

35     the end of the cycle, with results which are

qualitatively unsatisfactory owing to the difficulty of printing and danger involved in performing drying of the case already complete with primer.

Although fulfilling their function, these known methods  
5 have, however, drawbacks essentially consisting in the fact that they require several successive case machining operations with an increase in the cycle time, the need to lubricate the workpiece, with an increase in the complexity and cost of the forming  
10 machines, and the need for plants for ecological disposal of the cooling liquid.

In addition to this, the known techniques for graphic printing on a curved surface require the use of special machines which are per se costly and usually mono-  
15 colour and the operation must be performed at the end of the cycle since the successive drawing and die-forming steps would result in inevitable deterioration of the print.

In known cartridges the base of the case, which is  
20 normally made of brass or nickel-coated steel, is not painted, which results in a limited corrosion resistance, especially in the zones where shearing interrupts the coating layer.

The technical problem which is posed, therefore, is  
25 that of providing a device, an apparatus and a method for producing cartridge cases which provides a solution to the abovementioned problems, allowing a more rapid cycle time, the use of simpler and lower-cost forming machines and the possibility of graphically printing  
30 the case before forming thereof, also using several colours, among other things in order to improve its corrosion resistance and aesthetic properties.

These results are obtained according to the present invention by a die set, a machine and a method for  
35 forming a cartridge case according to the characteristic features of Claims 1, 27 and 54.

The present invention relates furthermore to a cartridge case according to the characteristic features of Claim 76.

Further details may be obtained from the following description of a non-limiting example of embodiment of the subject of the present invention provided with reference to the accompanying drawings, in which:

- Figure 1 shows a diagram illustrating a first mode of implementing the forming method according to the present invention;
- Figure 2 shows a perspective view of a second mode of implementing the method according to the present invention;
- Figure 3 shows a schematic cross-section along a vertical axial plane of the die set for producing cases according to the present invention, open in the rest condition;
- Figure 4 shows a cross-section similar to that of Fig. 3 with the die set in the contact condition ready for shearing;
- Figure 5 shows a cross-section similar to that of Fig. 3 with the die set during the shearing step;
- Figure 6 shows a cross-section similar to that of Fig. 3 with the die set during drawing of the case;
- Figure 7 shows a cross-section similar to that of Fig. 3 with the die set during extraction of the case; and
- Figure 8 shows an alternative example of embodiment suitable for performing engraving of the bottom of the case.

As shown in Fig. 1, the method according to the present invention for forming a cartridge case 1 comprises the following steps:

- a) supplying a sheet of metal 10 to a forming machine
- 20;
- b) single-stage drawing and boring performed by means

of a four-action die set with three coaxial movements;

c) extraction of the formed and punched case 1.

In more detail the sheet of metal 10 is cut to the predefined size by means of a cutting apparatus which is schematically shown in the form of a blade 11 and is conveyed to the forming machine 20 which is essentially composed of a press containing a three-part die set 1000 able to perform coaxial movements consisting in:

- cutting the disk 1a to be formed,
- single-stroke drawing in order to form the case 1,
- punching 1c the bottom 1b of the case,
- extracting the case.

In the case of manufacture of the case without lithographic printing, the press may be supplied directly with electrolytically lined and/or pre-painted steel.

According to the present invention it is envisaged that the case 1 extracted from the die set has a practically constant thickness, with any substantial difference between the side and bottom surface.

It is envisaged, moreover, that, in order to increase the productivity of the method, each press stroke should result in formation of a plurality of cases 1, this increase in the productivity being made possible by the fact that the multiple-action coaxial movements allow the manufacture of multiple-seat die sets 1000 where a single press stroke results in the forming of as many cases 1 as there are seats in the die set 1000. The drawing forces involved are considerably less than the drawing/die-forming forces of known processes and therefore greater productivity and savings in energy are achieved, without any modification of the dimensions of the press.

The case extracted from the press may then be conveyed away for the subsequent base widening steps or may be

conveyed directly to a station for performing personalized graphic printing.

The novel "soft" drawing process forming the subject of the present invention may be performed "in dry  
5 conditions" with considerable advantages also in terms of reduced environmental pollution, since it is not required to use lubricating and cooling oils which soil the case and require a subsequent tumbling/washing/polishing step with additional costs  
10 for the cycle and treatment of the resultant liquids.

In a preferred mode of implementation of the method, the material used for forming the case is chosen from among steel, aluminium and brass; preferably steel lined electrolytically with a film of metal such as  
15 brass, nickel, copper and/or plastic materials such as polyethylene and polyethylene terephthalates.

The preferred material is steel lined with tin owing to its high corrosion resistance properties and the absence of allergic or hygiene and ecology-related  
20 reactions.

Another preferred material is aluminium which, in addition to its intrinsic lightness, has the further advantage that it does not require corrosion protection means for the edges which remain exposed after  
25 shearing.

Fig. 2 shows a second example of implementation of the method according to the present invention which allows the production of cases 101 which are already printed graphically, also in several colours, at the moment of  
30 their extraction from the forming machine.

The method envisages in this case the following steps:

- a) supplying a metal sheet 10 to a lithographic printing machine 40 schematically shown with a pair of rollers 41;
- 35 b) lithographic printing of a surface of the sheet 10 by means of said rollers 41 and a conventional

- technique not described in detail;
- c) varnishing of the printed sheet with a layer of protective varnish by means of rollers 42;
  - d) polymerization of the print and protective varnish in special hot-air or UV ovens 50;
  - e) supplying the printed and varnished sheet of metal 110 to a forming machine 20;
  - f) drawing by means of a multiple-action die set with three coaxial movements;
  - g) extraction of the formed and punched case;
  - h) if required, personalization of the graphic print on the flat base of the case by means of multi-colour serigraphy or tampography;
  - i) if required, electrophoresis painting of the cut edges in the case of steel cases.

According to preferred embodiments the protective varnish applied to the print is of the polyester, polyurethane, epoxy ureic or epoxide type with zirconium, water or a low solvent content, while the inks for printing the logo are free of heavy metals.

The temperature of the hot-air oven is kept between 180° and 220°C and preferably between 195° and 205°C.

The graphic printing may also be performed on plastic film which is then made to adhere to the metal sheet.

As shown in Fig. 3 and in respect of the non-limiting orientation of the said figure, the die set 1000 for forming the case 1 comprises three support elements (plates), i.e. an upper plate 1100, middle plate 1200 and bottom plate 1300 which are connected together in the longitudinal direction by guide columns 1001 along which said support 1100 and bottom support 1300 are movable relative to each other.

In general it is possible to keep one of the three plates fixed and impart to the other two relative movements as in the preferred embodiment illustrated

and described hereinbelow in which the middle plate 1200 is kept fixed.

In more detail the middle plate 1200 comprises a sleeve 1210 extending in the axial direction and constrained  
5 to the said plate by means of internally threaded elements 1211 suitable for mating with the opposite threaded ends 1210a of the sleeve.

A blanking punch 1230 is coaxially arranged inside the sleeve and projects from the bottom side of the support  
10 1200, together with a closing bush 1220 constrained to the sleeve by means of a thread 1211a able to lock said punch 1230 inside said sleeve.

In a preferred embodiment the bush 1220 is axially locked with respect to the sleeve so as to allow the  
15 blanking punch 1230 to perform a small axial displacement of a few tenths of a millimetre against the thrusting action of a spring 1221 which is arranged coaxially inside the bush 1220 and opposes said displacement, this being useful for ensuring gripping  
20 of the cut disk 10 between the blanking punch 1230 and upper surface of the drawing die 1330.

The opposite ends of the spring 1221 bear respectively against the said blanking punch 1230 and against a closing element 1222 provided with a thread for  
25 adjusting the load of said spring.

The middle plate 1200 also has, integral therewith, a sheet pressing element 1231 which has the function of clamping the metal sheet (during the shearing step) and the resultant waste during the forming step; said  
30 sheet-pressing element is suspended from the middle plate by means of pins 1231a and springs 1231b which allow displacement thereof relative to said middle plate 1200.

The closing element 1222, the spring 1221 and the  
35 blanking punch 1230 also have passing through them coaxially a rod 1241, the top end of which is

integrally joined to the upper plate 1100 with the arrangement of a spring 1243 in between and the bottom end of which carries the drawing punch 1240; the rod 1241 has passing through it axially a duct 1242 for supplying air to the drawing punch 1240.

The end surface 1240a of the drawing punch 1240 has a cavity 1241b which forms a constriction for entry of the boring punch 1353.

The end part of the drawing punch 1240 directed towards the top of the die set has a seat 1245a able to contain a ring 1245 of hard shearing material, the purpose of which will become obvious below with respect to operation of the die set.

The bottom plate 1300 has, inserted inside it, a shearing die 1330 inside which the drawing die 1340, an extractor 1360 and a boring punch 1350 are coaxially arranged.

In more detail the shearing die 1330, the drawing die 1340 and the boring punch 1350 are axially fixed to the plate 1300, with the punching die keyed so that the height of its flat upper surface lies slightly below that of the cutting edges of the shearing die 1230, while the extractor 1360 is formed by a cup member 1361 movable axially against the thrusting action of a spring 1362 and/or an equivalent gas piston; the said cup member 1361 also has an opening 1361a able to allow the tip 1353 integral with the top end of the column 1352 of the boring punch 1350 to pass through.

The entire assembly is retained inside the support seat 1300 by a closing element 1310.

With reference to Figs. 4, 5, 6 and 7 the operating principle of the die set is as follows:

- a) with the die set totally open (Fig. 3), the sheet of metal 10 is introduced between the bottom plate 1300 and the sheet-pressure plate 1231;
- b) the bottom support 1300 is raised so that the

- sheet pressing element 1231 is operated, allowing:
- c) cutting of the sheet metal by the shearing die 1330 against the reaction of the blanking punch 1230; the disk 10 thus cut is positioned inside the hole of the shearing die and is now compressed and retained between the bottom surface of the blanking punch 1230 and the top surface of the drawing die 1340 by means of the spring 1221 which presses against the blanking punch 1230;
  - d) at this point closing of the upper plate 1100 is performed, which plate, descending towards the bottom plate, brings the drawing punch 1240 into contact with the disk 10;
  - e) continuing its axial stroke, the drawing punch 1240 enters inside the drawing die 1340, causing forming of the case 1;
  - f) lowering of the cup member 1361 against the thrusting action of the spring 1362;
  - g) penetration of the tip 1353 of the boring punch through the bottom 1b of the case 1 which is thus pierced with a hole 1c;
  - h) at the same time as boring of the case 1, the shearing ring 1245 comes into contact with the upper annular edge 2 (or "trimming rim") of the case 1, causing separation thereof from the said case; this operation is necessary to ensure a uniform and precise height of the case, which otherwise would be irregular because of the anisotropy always present in the starting metal.
  - i) the upper plate 1100 and the bottom plate 1300 are displaced so that they are each moved away from the central support 1200, so as to produce opening of the die set;
  - j) supplying at the same time air to the duct 1242 in the rod 1241 of the drawing punch 1240;
  - k) in this way the air introduced causes separation

of the formed case from the forming punch, facilitates the expulsion of the trimming rim 2 and ensures perfect removal of any metal residue from the seat of the blanking punch 1230;

- 5     1) the return of the cup member 1361 into its rest position acted on by the spring 1362, which return movement causes expulsion of the formed and bored case 1 from the die set.

10     The characteristic feature of the die set is therefore that of comprising three elements for shearing, drawing and boring, which are all coaxial with each other and able to act in a single sequence of axial movements; this enables, among other things, the manufacture of modular die sets with several seats for the  
15     simultaneous forming of several cases during the same working cycle, with an obvious reduction in machining waste, an increase in the productivity and a reduction in the amount of machine idle time affecting the cost of the product.

20     As can be seen from Fig. 8, it is also possible to envisage the possibility of performing an engraving in the bottom of the case during the forming step; in such a case it is envisaged that the boring punch 1352 comprises an annular surface 1370 arranged coaxially  
25     with the said punch at a suitable axial distance from the boring tip 1353. The said annular surface 1370 is provided with engraving reliefs 1371, 1372 for example corresponding to the logo of the manufacturer and the calibre of the cartridge.

30     Correspondingly the forming punch 1240 has a free surface associated with a surface 1270 having, formed therein, recesses 1271, 1272 corresponding to the reliefs 1371, 1372 on the annular engraving surface 1370.

35     In this way the penetration of the boring tip inside the drawing punch causes compression of the base of the

case between the two male and female engraving dies which correspondingly engrave the said base.

A machine for forming the case 1 according to the present invention is essentially composed of a press  
5 (conventional per se and therefore neither illustrated nor described in detail) inside which the die set 1000 described above is inserted; said press may be of the multiple-action type with a die set which is actuated by connecting rods and/or cams and/or oil-hydraulic  
10 and/or gas cylinders and operates with the sequence described above for operation of the die set, by means of operation and control of the cycle sequences within the knowledge of a person skilled in the art.

It is therefore evident how the machine according to  
15 the invention is able to achieve the production, in a single cycle, of the finished case without intermediate extraction and recovery thereof.

In addition the coaxial movements of the die set allow the provision of multiple dies equipped with a  
20 plurality of seats and punches for producing a plurality of cases during the same machine cycle.

It is pointed out also how, owing to the possibility of producing the case with a single drawing stroke, it also possible to avoid lubrication of the workpiece and  
25 to form the case from a ready-printed sheet; the single forming stroke in fact does not cause deterioration of the print as instead occurs in the known art and as in the case of series of strokes or die-forming operations necessary for forming the case.

A further effect of the invention consists in the fact  
30 that the clean condition of the case upon leaving the press allows the application of a personalized logo on the case using simple and inexpensive printing methods for transferring colours, such as for example  
35 tampography and/or serigraphy for the flat base of the case or using more complex graphic machines for the

cylindrical side surface; it being possible in both cases to envisage the use of printing apparatus arranged in line with the forming press.

5     An example of these printing processes consists in the technology which uses an electronic pen for depositing/fixing covering layers on metal sheets; in this configuration the elements 42 and 50 according to Fig. 2 will be replaced by such apparatus.